

# Infrastructure for Sustainable Development Using Renewable Energy Technologies in India



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# Agenda

- Need for renewable energy in sustainable development
- Key issues in deployment of renewable energy resources
- Enabling technologies
- Role of European Union and United Nations
- Sustainable development in India
- Conclusion

# Key issues in sustainable energy development

- Technology selection
- Investment
- Intermittency and availability
- Grid integration
- Fuel requirement
- Environmental issues and role of technologies
- Regulatory policy and demand side management

# Sustainability matrix for Indian scenario

	Potential available	Per kW installation cost	Emissions	Maintenance cost	Fuel cost	Weather/Location dependency	Reliability	Technology status	Life span	Regulatory issues	Modularity	Index
Index weight (%)	15	33	8	5	12	5	9	8	1	3	1	100
Small hydro	6	6	10	8	5	5	8	8	9	7	1	7.20
Wind	9	7	10	9	5	5	7	9	9	9	2	8.09
Solar	7	1	10	9	6	6	7	7	9	4	9	5.62
Energy from waste	2	8	7	7	8	8	9	2	7	3	8	6.06
Biomass	7	9	8	6	9	9	9	8	8	7	7	8.06
Bagasse	7	9	8	6	7	7	9	8	8	7	5	7.94
Biofuel	6	8	8	7	8	8	9	7	8	5	9	7.34
Tidal power	1	2	10	5	8	8	7	2	8	1	1	4.37

# Enabling technologies

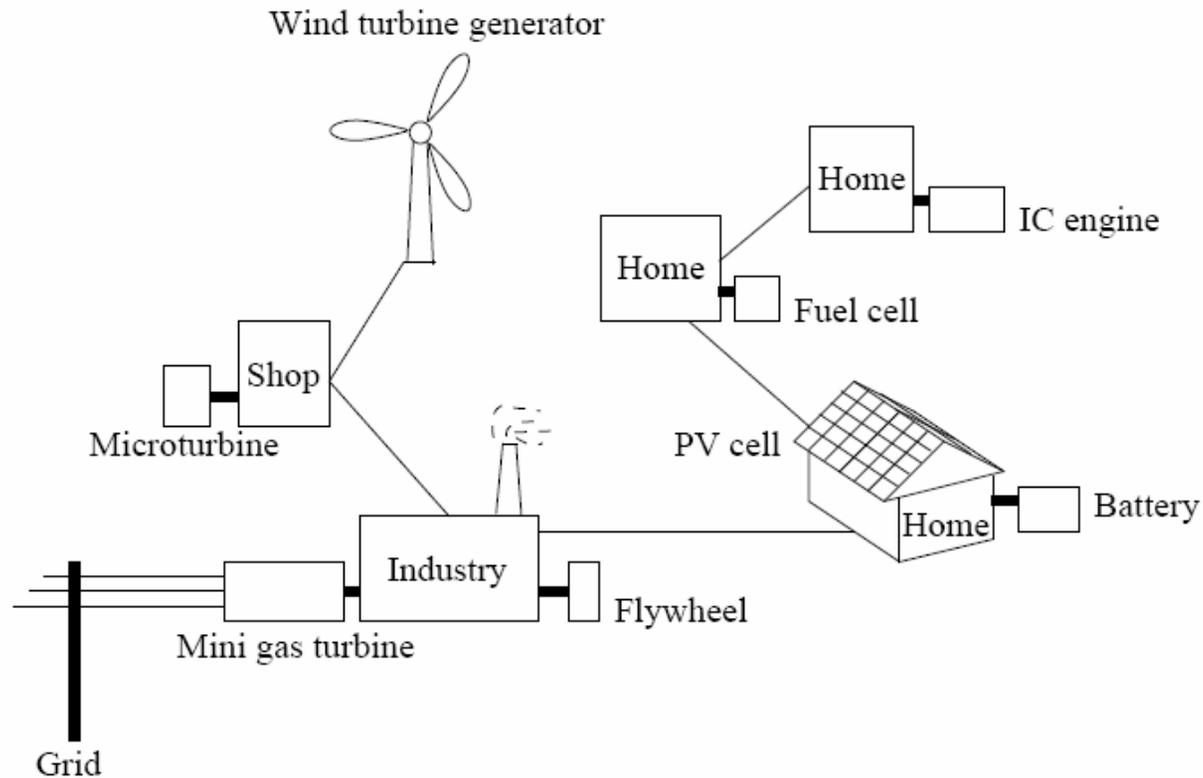
1. Standards development
2. Energy storage technologies
3. MicroGrid
4. Information and communication technologies

# Infrastructure development with renewables

- Standards development
  - Need of standards
  - IEC 61850 for substation automation
  - IEEE 1547 for grid integration of DERs
- Storage devices
  - Role of storage devices with renewable energy sources
  - Battery, flywheel, ultra-capacitor, SMES, pumped hydro, compressed air energy storage, hydro energy storage

# Why MicroGrid?

- Stand-alone renewable energy source
- Hybrid energy source
- Role of MicroGrid



# MicroGrid

- Advantages:
  - Advantage of networking at mini scale
  - Use diversity of technology and load to increase reliability and decrease reserve requirement
  - Reducing the reserve capacity required
- Is a MicroGrid justified solution?
  - Cost of energy to the consumer may be higher
  - Go for multi objective decision making (MADM)

# Information and communication technologies (ICT)

- Universal connectivity
- Open architecture and web services
- Increasing the intelligence of the grid
- Managing services over internet and web

# Features of the SMARTGRID project by EU

- Advanced fault detection and handling
- Intelligent load shedding
- Use of Agents
- Supporting Electronic market

# Support for sustainability by different organizations

- European Union

- Research and technology development (RTD) activities and the European Union (EU) framework program (FP)
- Stress upon renewable power generation

- United Nations

- United Nations (UN) conference on new and renewable sources of energy held in the year 1981 in Nairobi, Kenya
- The UN efforts enabled several countries like China, Egypt, India, Thailand, Mexico, and Brazil to prepare solar and wind data handbooks and atlases

# Sustainable development in India

- India's goals
- Economic growth rate of 8% to 10 % over next 25 year
- Increase generation capacity by five times

Installed capacity in MW as on 30-10-2006

Sector	Hydro	Thermal			Nuclear	RES	Total
		Coal	Gas	Diesel			
State	25635.2	38239.9	3499.8	604.6	0.0	2567.5	70547.0
Private	1292.7	4241.4	5663.0	597.1	0.0	3623.3	15417.5
Central	6422.0	26717.5	4419.0	0.0	3900.0	0.0	41458.5
Total	33349.9	69198.8	13581.8	1201.7	3900.0	6190.8	127423.0

# Renewable energy in India

- Wind and biomass based resource are on top priority

Renewable technology	Potential	Achievement in MW	India's rank in the world
Wind	45000	6070.20	4
Biomass power	19500	912.53	4
Biomass gasifier	NA	69.87	1
Solar PV cell	20 MW/km <sup>2</sup>	2.74	5
Small hydro (<25 MW)	15000	1826.43	10
Energy from waste	2700	45.78	NA

## Promoting renewable energy

- Renewable power purchase obligation (RPPO) by state electricity regulatory commissions (SERCs)

State	Renewable energy (% of total consumption)
Andhra Pradesh	Minimum 5%
Madhya Pradesh	0.5%
Karnataka	5% to 10%
Gujarat	1%
Maharashtra	3%
Tamil Nadu	10%

## Ministry for renewable energy

- The ministry of new and renewable energy sources (MNRE) previously known as MNES
  - supporting R&D for technology and manpower development in renewable energy
  - the thrust areas mainly covers programs related to rural electrification using solar energy, energy from urban and industrial wastes, wind power generation, biomass, small hydro, etc.
- Indian renewable energy development agency limited (IREDA)
  - Under the administrative control of MNRE
  - It promotes, develops and extends financial assistance for renewable energy and energy efficiency/conservation projects

# Case study of renewable power generation in India

- Why case study of Biomass power generation?

## Biomass availability in India

Biomass	Quantity in million tons per year
Straw of variable pulses & cereals	225.6
Bagasse	31
Rice husks	10
Groundnut sell	11
Stalks	2
Various oil stalks	4.5
Other	65.9
Total	350

## Biomass plant details

- 10 MW plant in the state of Maharashtra, India
- Requirement of 85000 tons biomass per year

Biomass	Cost in USD/ton	Quantity in tons per year
Cotton stalks	17	25000
Red gram stalks	17	58000
Soyabean stalks	17	
Rice husk	22	
Wood	33	2000

1 USD = 45 INR

# Techno-economics of biomass plant

- Technology selection
  1. Direct burning of biomass in furnace
  2. Biomass is converted into liquid fuel like methanol, ethanol, etc.
  3. Biomass converted into gaseous fuel
- Method 1 is suitable for plants > 1 MW
- Economics of the plant
- Total investment is estimated around 9 million USD. The funding is managed in two parts, 2.7 million USD from equity share capital and 6.3 million USD from loans

# Plant economics

Availability	90.4%
Plant load factor	0.75-0.8
Internal consumption	12% of gross consumption
Selling price	7cents/kWh + 1% annual increase
Operation and maintenance cost	5% of fixed assets
Interest rate	12%
Subsidies	NIL

internal rate of return (IRR) is 17.44%

# Major obstacles in exploring renewable energy

Private investment in renewable energy contributes to more than 60 %

- Lack of availability of financial support
- Lack of government policies
- Undue advantages taken by private players

# Conclusion

- The volatility of fossil fuel prices has opened a ground for renewable energy sources
- The renewable energy technologies and other non-conventional technologies will play an important role to enable the sustainable development
- With the inherent unpredictability, the wind and PV cell should be supported by upcoming technologies like MicroGrid and ICT
- Large scale implementation of the renewable energy resources need to have motivating government policies and well established standards
- Proper financial support is the governing factor for a generation deficient and developing country like India

# Thank You

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